CLAIMS

What is claimed is:

1. A system for treatment of flue gas from a coal fired circulating fluidized bed reactor, comprising a wet scrubber operatively connected to the circulating fluidized bed reactor and configured for treating the flue gas.

2. The system of claim 1, wherein the wet scrubber is a member selected from the group consisting of gas phase scrubber, liquid phase scrubber, and combinations thereof.

3. The system of claim 2, wherein the wet scrubber is a liquid phase scrubber.

4. The system of claim 3, wherein the wet scrubber is a spray tower scrubber.

5. The system of claim 2, wherein the wet scrubber is a gas phase scrubber, said scrubber being a member selected from the group consisting of venturi scrubber, plate tower scrubber, and orifice scrubber.

6. The system of claim 2, wherein the wet scrubber is a combination liquid-gas phase scrubber, said scrubber being a member selected from the group consisting of packed tower scrubber, wet film scrubber, cyclonic spray scrubber, mobile or moving bed absorber, and baffle spray absorber.

7. The system of claim 1, wherein a particulate collection system is operatively connected between the circulating fluidized bed and the wet scrubber.

8. The system of claim 7, wherein particulate collection system is a baghouse, electrostatic precipitator, multiclone, or venturi scrubber.

9. The system of claim 1, further comprising a dry scrubber operatively connected between the circulating fluidized bed and the wet scrubber.

10. The system of claim 9, wherein the dry scrubber is selected from the group consisting of spray dryer absorber, flash dryer absorber, dry sorbent injectors, and combinations thereof.

11. The system of claim 10, wherein the dry scrubber is a spray dryer absorber or flash dryer absorber.

12. The system of claim 1, wherein the system for treatment of flue gas is adapted to reduce sulfur oxide emissions by from about 95% to about 100%.

13. The system of claim 12, wherein the system for treatment of flue gas is adapted to reduce sulfur oxide emissions by from about 99% to about 100%.

14. The system of claim 1, wherein the system for treatment of flue gas is adapted to reduce emissions of at least one of nitrogen oxides, carbon monoxide, arsenic, beryllium, cadmium, hydrochloric acid, chromium, cobalt, hafnium, lead, manganese, mercury, nickel, selenium, benzo(a)pyrene, and combinations thereof.

15. The system of claim 14, further comprising a mercury removal device operatively connected to the coal fired circulating fluidized bed reactor.

16. The system of claim 14, further comprising a nitrogen oxide reduction device operatively connected to the coal fired circulating fluidized bed reactor.

17. A system for treatment of flue gas from a coal fired reactor, comprising:

a) a particulate collection apparatus operatively connected to the coal fired reactor and configured to produce a low particulate flue gas;

b) a first wet scrubber operatively connected to the particulate collection apparatus and configured for scrubbing the flue gas and producing a treated flue gas; and

c) a second wet scrubber operatively connected to the first wet scrubber and configured for scrubbing the treated flue gas to produce a low sulfur oxide flue gas.

18. The system of claim 17, wherein the first and second wet scrubbers are independently selected from the group consisting of gas phase scrubber, liquid phase scrubber, and combinations thereof.

19. The system of claim 18, wherein the first and second wet scrubbers are each a liquid phase scrubber.

20. The system of claim 19, wherein said first wet scrubber is a spray tower scrubber and said second wet scrubber is a mobile or moving bed scrubber.

21. The system of claim 17, wherein the first and second wet scrubbers are independently selected from the group consisting of spray tower scrubber, venturi scrubber, plate tower scrubber, orifice scrubber, packed tower scrubber, wet film scrubber, cyclonic spray scrubber, mobile or moving bed absorber, baffle spray absorber, and combinations thereof.

22. The system of claim 21, wherein the system is adapted to reduce sulfur oxide content of the flue gas from about 95% to about 100%.

23. The system of claim 17, wherein the coal fired reactor is a circulating fluidized bed reactor.

24. The system of claim 17, wherein the coal fired reactor is a pulverized coal reactor.

25. The system of claim 17, wherein said particulate collection system is a baghouse, electrostatic precipitator, multiclone, or venturi scrubber.

26. The system of claim 17, wherein the system for treatment of flue gas is adapted to reduce emissions of at least one of nitrogen oxides, carbon monoxide, arsenic, beryllium, cadmium, hydrochloric acid, chromium, cobalt, hafnium, lead, manganese, mercury, nickel, selenium, benzo(a)pyrene, and combinations thereof.

27. The system of claim 26, further comprising a mercury removal device operatively connected to the coal fired reactor.

28. The system of claim 26, further comprising a nitrogen oxide reduction device operatively connected to the coal fired reactor.

29. A method of decreasing toxic emissions from a coal fired combustion unit comprising the steps of:

a) removing particulates from flue gas of the coal fired combustion unit to produce a low particulate flue gas;

b) treating low particulate flue gas using a first wet scrubber to produce a treated flue gas; and

c) treating the treated flue gas with a second wet scrubber to produce a low sulfur flue gas.

30. The method of claim 29, wherein the first and second wet scrubbers are independently selected from the group consisting of gas phase scrubber, liquid phase scrubber, and combinations thereof.

31. The method of claim 29, wherein the first and second wet scrubbers are independently selected from the group consisting of spray tower scrubber, venturi scrubber, plate tower scrubber, orifice scrubber, packed tower scrubber, wet film scrubber, cyclonic spray scrubber, mobile or moving bed absorber, baffle spray absorber, and combinations thereof.

32. The method of claim 29, wherein the coal fired combustion unit is a circulating fluidized bed reactor.

33. The method of claim 32, further comprising the step of recycling unused lime into the wet scrubber.

34. The method of claim 29, wherein the coal fired combustion unit is a pulverized coal reactor.

35. The method of claim 29, wherein sulfur oxide emissions are reduced from about 95% to about 100%.

36. The method of claim 35, wherein the sulfur oxide emissions are reduced from about 99% to about 100%.

37. A method of decreasing sulfur oxide emissions from a coal fired circulating fluidized bed reactor comprising the step of treating flue gas from the coal fired combustion unit using a first wet scrubber to produce a treated flue gas.

38. The method of claim 37, wherein the first wet scrubber is selected from the group consisting of gas phase scrubber, liquid phase scrubber, and combinations thereof.

39. The method of claim 38, wherein the first wet scrubber is a liquid phase scrubber.

40. The method of claim 39, wherein the first wet scrubber is a spray tower scrubber.

41. The method of claim 38, wherein the first wet scrubber is a gas phase scrubber, said scrubber being a member selected from the group consisting of venturi scrubber, plate tower scrubber, and orifice scrubber.

42. The method of claim 38, wherein the first wet scrubber is a combination liquid-gas phase scrubber, said scrubber being a member selected from the group consisting of packed tower scrubber, wet film scrubber, cyclonic spray scrubber, mobile or moving bed absorber, and baffle spray absorber.

43. The method of claim 37, further comprising a dry scrubber operatively connected between the circulating fluidized bed and the first wet scrubber.

44. The method of claim 43, wherein the dry scrubber is selected from the group consisting of spray dryer absorber, flash dryer absorber, dry sorbent injector, fluidized bed absorber, and combinations thereof.

45. The method of claim 37, wherein sulfur oxide emissions are reduced by from about 95% to about 100%.

46. The method of claim 45, wherein the sulfur oxide emissions are reduced by from about 99% to about 100%.

47. A system for treatment of flue gas from a coal fired reactor, comprising:

a) a particulate collection apparatus operatively connected to the coal fired reactor and configured to produce a low particulate flue gas;

b) a first dry scrubber operatively connected to the particulate collection apparatus and configured for scrubbing the flue gas and producing a treated flue gas; and

c) a second dry scrubber operatively connected to the first dry scrubber and configured for scrubbing the treated flue gas to produce a low sulfur oxide flue gas.

48. The system of claim 47, wherein the first and second dry scrubbers are independently selected from the group consisting of spray dryer absorber, flash dryer

absorber, dry sorbent injector, fluidized bed absorber, circulating dry scrubber, and combinations thereof.

49. The system of claim 48, wherein said first dry scrubber is a dry sorbent injector and said second dry scrubber is a spray dryer absorber.

50. The system of claim 47, wherein the system is adapted such that the low sulfur oxide flue gas has a sulfur oxide content from about 95% to about 100% lower than a sulfur oxide content of the flue gas.

51. The system of claim 47, wherein the coal fired reactor is a circulating fluidized bed reactor.

52. The system of claim 47, wherein the system for treatment of flue gas is adapted to reduce emissions of at least one of nitrogen oxides, carbon monoxide, arsenic, beryllium, cadmium, hydrochloric acid, chromium, cobalt, hafnium, lead, manganese, mercury, nickel, selenium, benzo(a)pyrene, and combinations thereof.

53. The system of claim 52, further comprising a mercury removal device operatively connected to the coal fired reactor.

54. The system of claim 52, further comprising a nitrogen oxide reduction device operatively connected to the coal fired reactor.

55. A method of decreasing toxic emissions from a coal fired combustion unit comprising the steps of:

a) removing particulates from flue gas of the coal fired combustion unit to produce a low particulate flue gas;

b) treating low particulate flue gas using a first dry scrubber to produce a treated flue gas; and

c) treating the treated flue gas with a second dry scrubber to produce a low sulfur flue gas.

56. The method of claim 55, wherein the first and second wet scrubbers are independently selected from the group consisting of spray dryer absorber, flash dryer absorber, dry sorbent injector, fluidized bed absorber, circulating dry scrubber, and combinations thereof.

57. The method of claim 56, wherein said first dry scrubber is a dry sorbent injector and said second dry scrubber is a spray dryer absorber.

58. The method of claim 55, wherein said coal fired combustion unit is a circulating fluidized bed reactor.

59. The method of claim 55, wherein sulfur oxide emissions are reduced from about 95% to about 100%.

60. The method of claim 48, further treating the flue gas to reduce the level of mercury from about 90% to about 100%.